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St. Lutz / U. Kletzin / H.-J. Schorcht

Application of tube springs – one method of lightweight construction of suspensions

ENGINEERING DESIGN

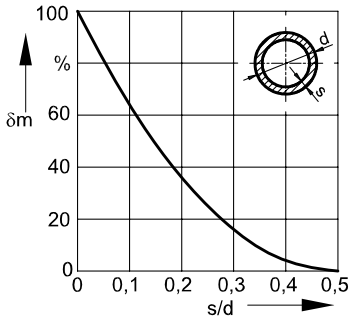
Also to springs as classic machine elements for storage and transformation of mechanical energy always higher requirements will be made. Beside the need of higher precision and higher reliability in performance of desired function it concerns first of all the need of decreasing off mass and constructed space. This establishes preconditions for light and compact products including spring assemblies.

To realise the need for lightweight design of springs and spring assemblies there are the following options: application of lightweight material, application of high-strength material, higher stress efficiency and certainly the combination of all these options.

The realisation of a better stress efficiency of the available material leads in particular in bending and torsion stressed springs to innovative solutions. In this kind of springs only the outer area of the wire material is used until the allowable stress [1]. In the inner area near the bending or torsion axis appear considerable lower stresses down to zero. This leads to the idea, to use hollow section instead of full section wire for the production of springs [2]. However for bending springs and for coil springs because of technological and material problems no applications are known.

The rate of reachable reduction of material respectively mass δm is dependent on wall thickness s of hollow section: as smaller the wall thickness s in comparison to the diameter d, as bigger is the reduction rate δm (picture 1). Limits for wall thickness are given in the production process of the wire or tube and the forming process of the tube material to the spring. In this process only small deformations of the cross-section are allowed. Difficult in choice of a convenient wall thickness affect also limited calculation potentials for stress distribution over the material cross-section. The assumptions of linear elastic theory in classic spring calculation are only applicable for small deformations and approximate calculations [1]. They reflect the stresses inside the cross-section of deformed tubes only insufficient. Also a modification of stresses because of secondary treatment

processes of the spring (tempering, shot peening, presetting) is not included.



picture 1: wall thickness and material reduction

picture 2: coil spring made of tube material

The lecture presents first results and experiences in realisation this innovative idea of material reduction at coil springs of tube material (picture 2) [3]. Beginning with the discussion of the problem and the procedure in classic spring calculation the options of approximate calculation using tube material are presented. After this the application of finite element method for computation of stress distribution across and along the tube is shown. Thereby also the way to an automated finite element modelling is presented [4]. At last results of manufacturing and testing of the first sample springs are discussed and the next necessary steps are formulated.

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